Detection of a non-Gaussian Spot in WMAP

Marcos Cruz

IFCA, Santander

IAP Colloquium Paris 2004

Detection of a non-Gaussian Spot in WMAP

- Introduction

- Data and Simulations

- Spherical Mexican Hat Wavelet

- Estimators

- The Analysis

- Conclusions

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Introduction

- CMB: Temperature fluctations

- Standard inflation $\rightarrow$ Gaussianity

- Sources of non-Gaussianity
  - Topological defects
  - Non-standard inflation
  - Foregrounds
  - Systematics
  - Etc.
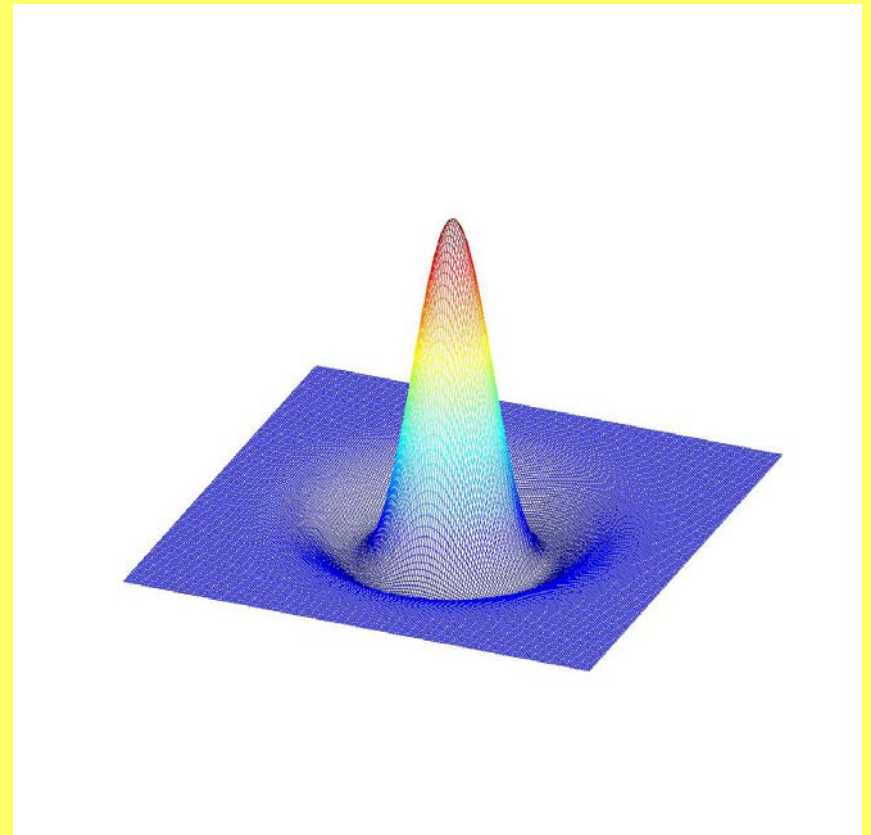
Introduction: Previous results

- WMAP 1-year data

- WMAP-team (Komatsu et al. 2003) → Gaussianity

- Non-Gaussianity and/or asymmetry :
  - Chiang et al. 2003, Park 2003, Eriksen et al. 2003, 2004, Hansen et al. 2004a,b, Larson & Wandelt et al. 2004, Mukherjee & Wang 2004, …
  - **Vielva et al. 2003**: kurtosis → cold spot
  - **Spots?**

Introduction: Methods

- Several methods
  - Minkowski functionals
  - N-point correlation functions
  - Local curvature methods
  - …
  - **Spherical Mexican Hat Wavelet**

Spherical Mexican Hat Wavelet

- Higher SNR
- Scale R
- Preserves spatial location

Stereographic projection: Antoine & Vanderheynst (1998)

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Data and Simulations

- ## WMAP 1-year data
    - Combined (cleaned) Q-V-W map (not ILC)
    - Kp0 mask + extended mask

- ## 10000 Gaussian Simulations
    - Cosmological parameters (Spergel et al. 2003)
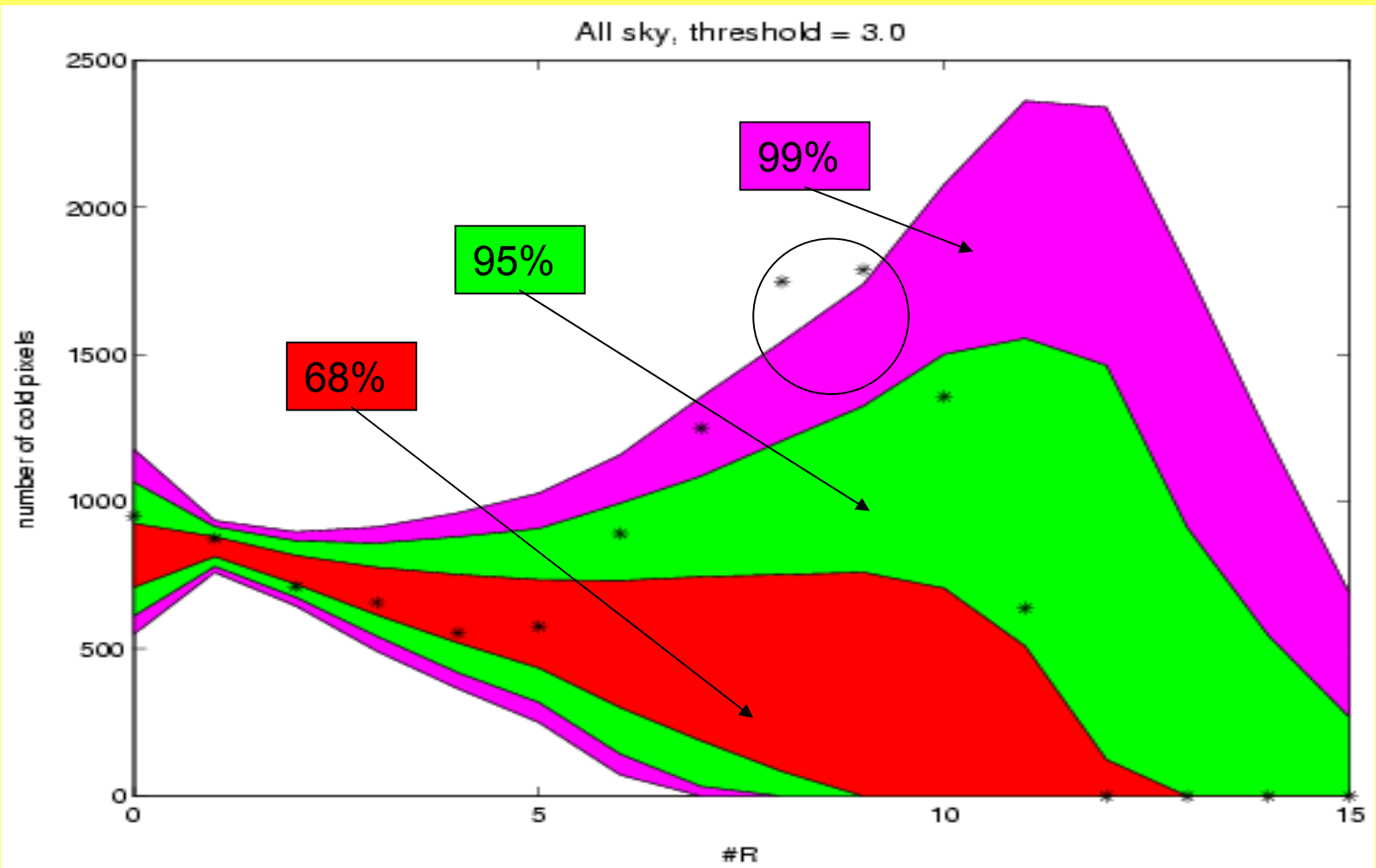   - Beam and noise
    - Kp0 mask + extended mask

Estimators

- Threshold ν = 2.0, 2.5, 3.0, 3.5, 4.0, 4.5
  - Number of maxima
  - Number of hot spots
  - Number of hot pixels = hot area
- Threshold ν = -2.0,-2.5,-3.0,-3.5,-4.0,-4.5
  - Number of minima
  - Number of cold spots
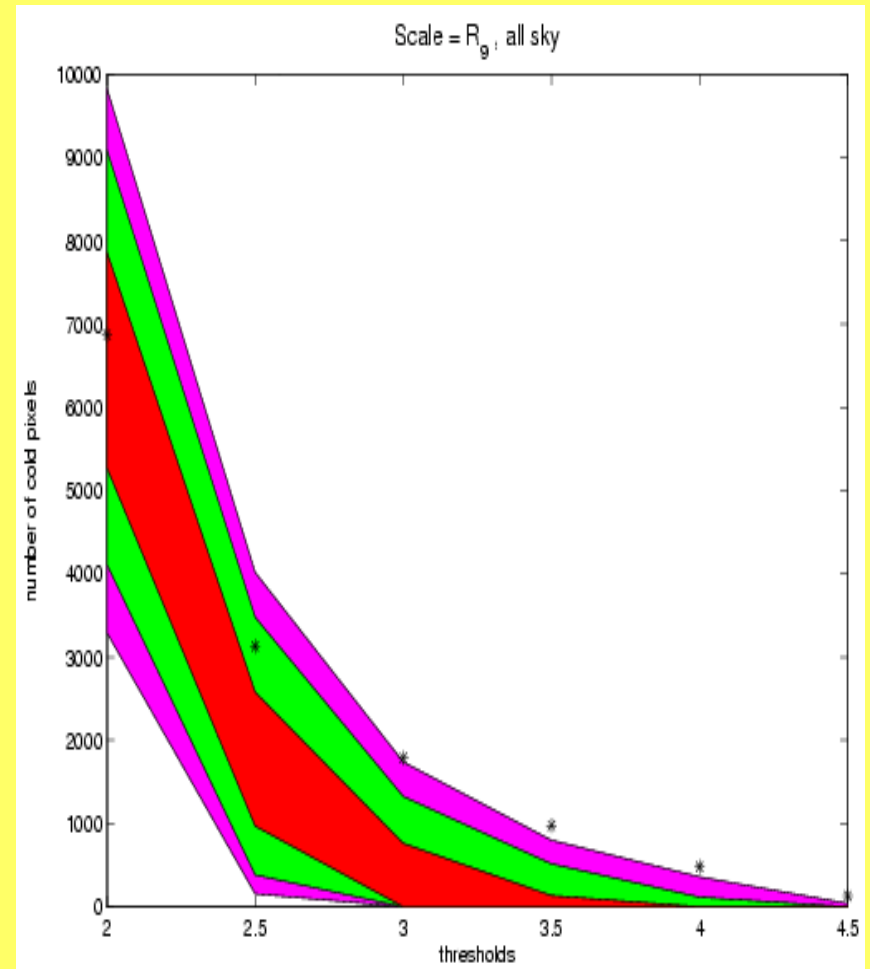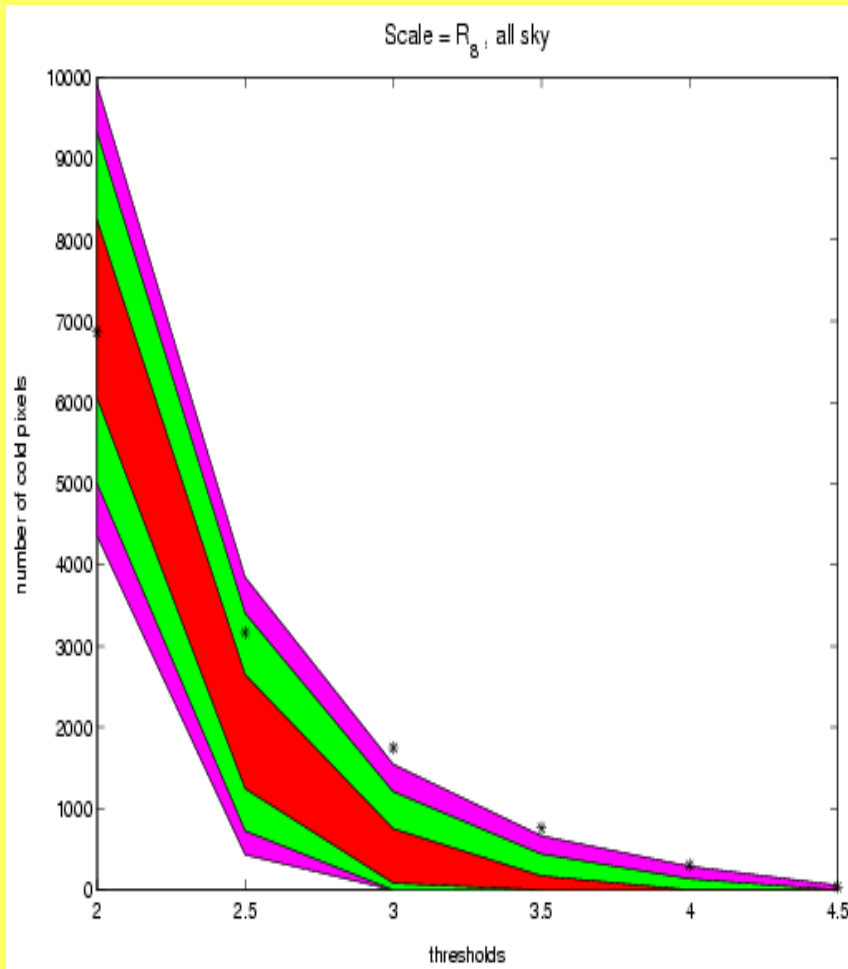 - Number of cold pixels = cold area

The Analysis

- 15 scales from 13.74 to 1050 arcmin
- All scales: **Cold area**
- Scales 8, 9 = 250, 300 arcmin
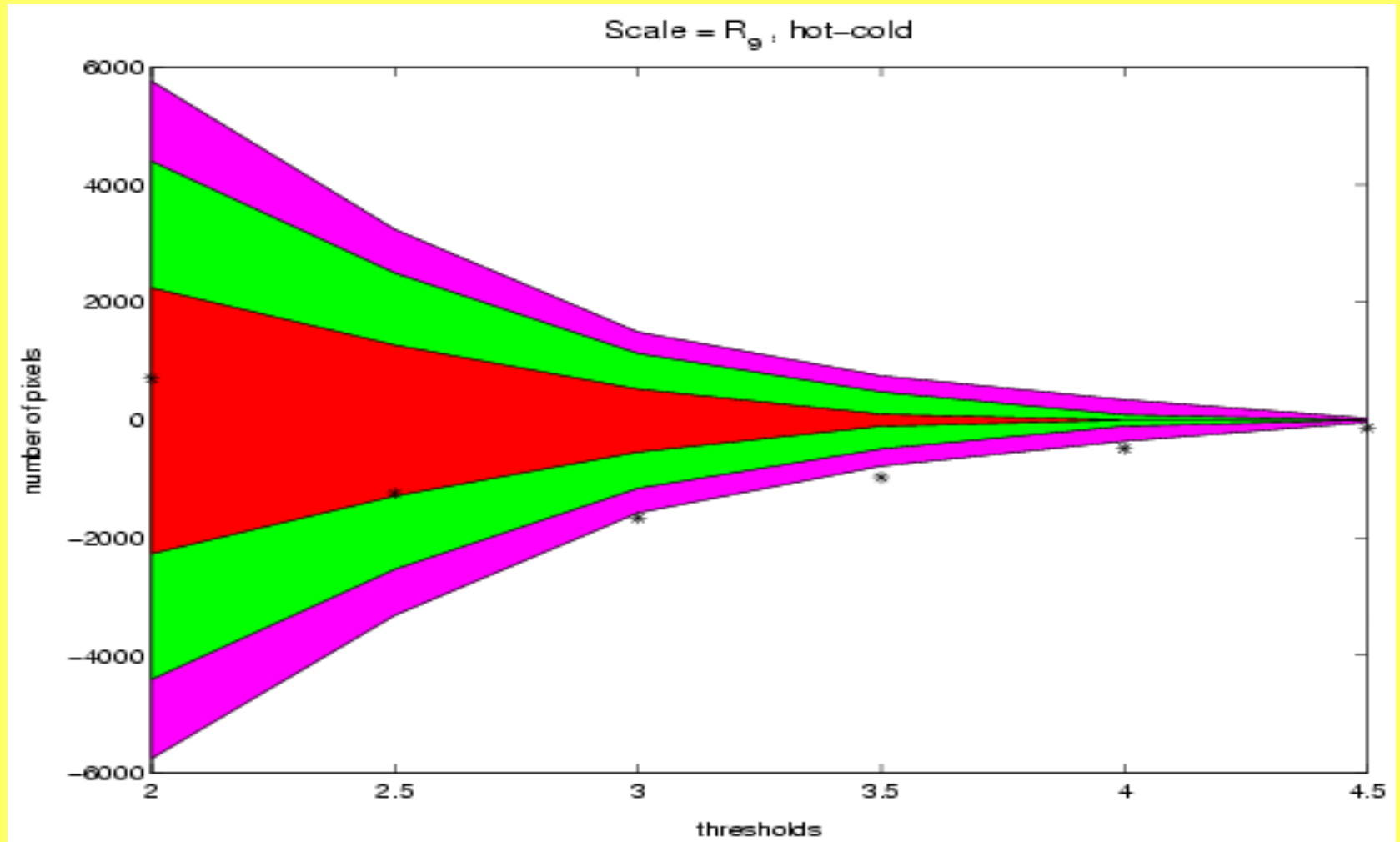- Hot - Cold
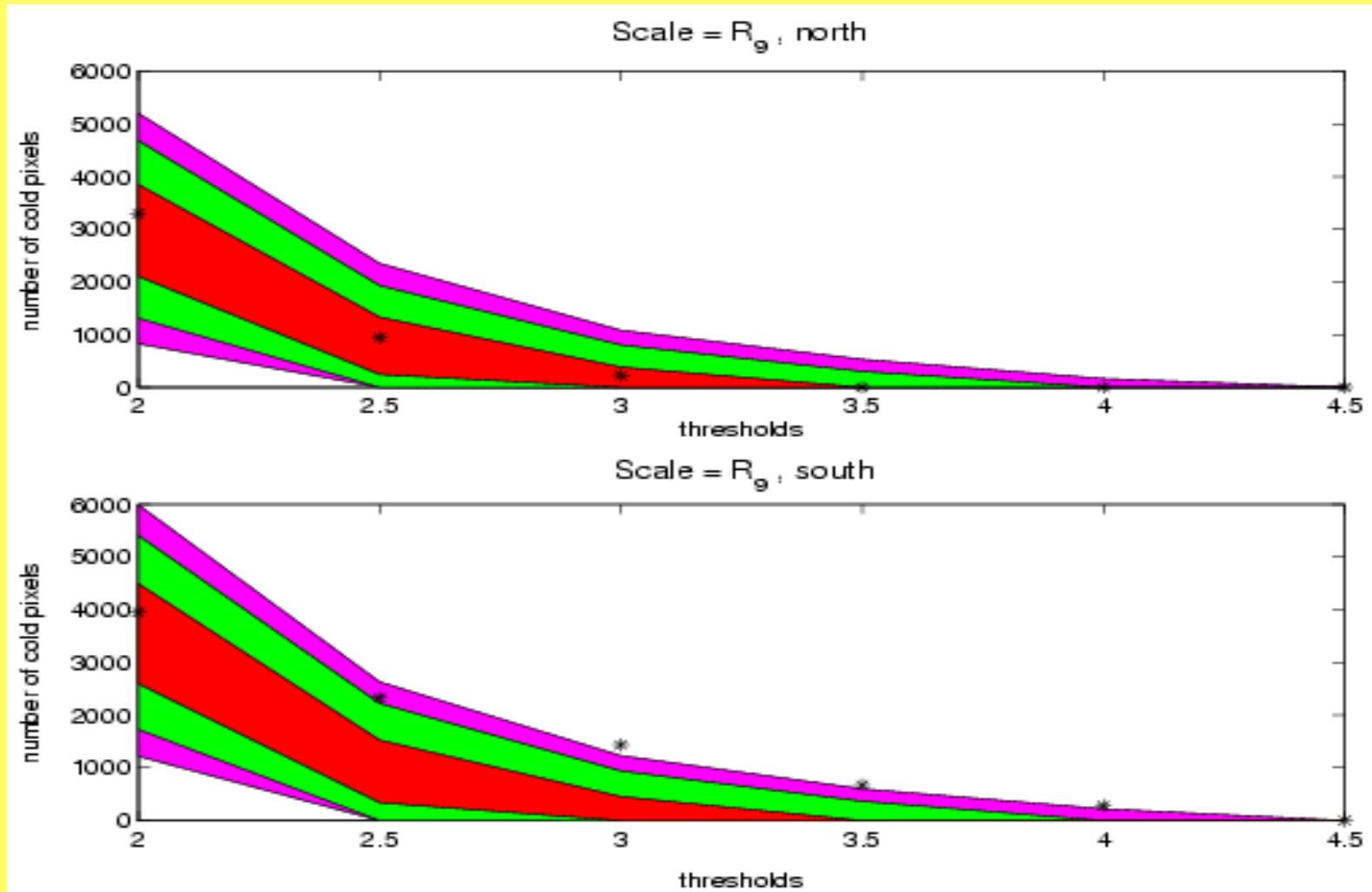- North and South
- The Spot

All scales: cold area

All sky, threshold = 3.0

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Scales 8, 9 : cold area

Hot – cold area

Scale = R_9 : hot–cold

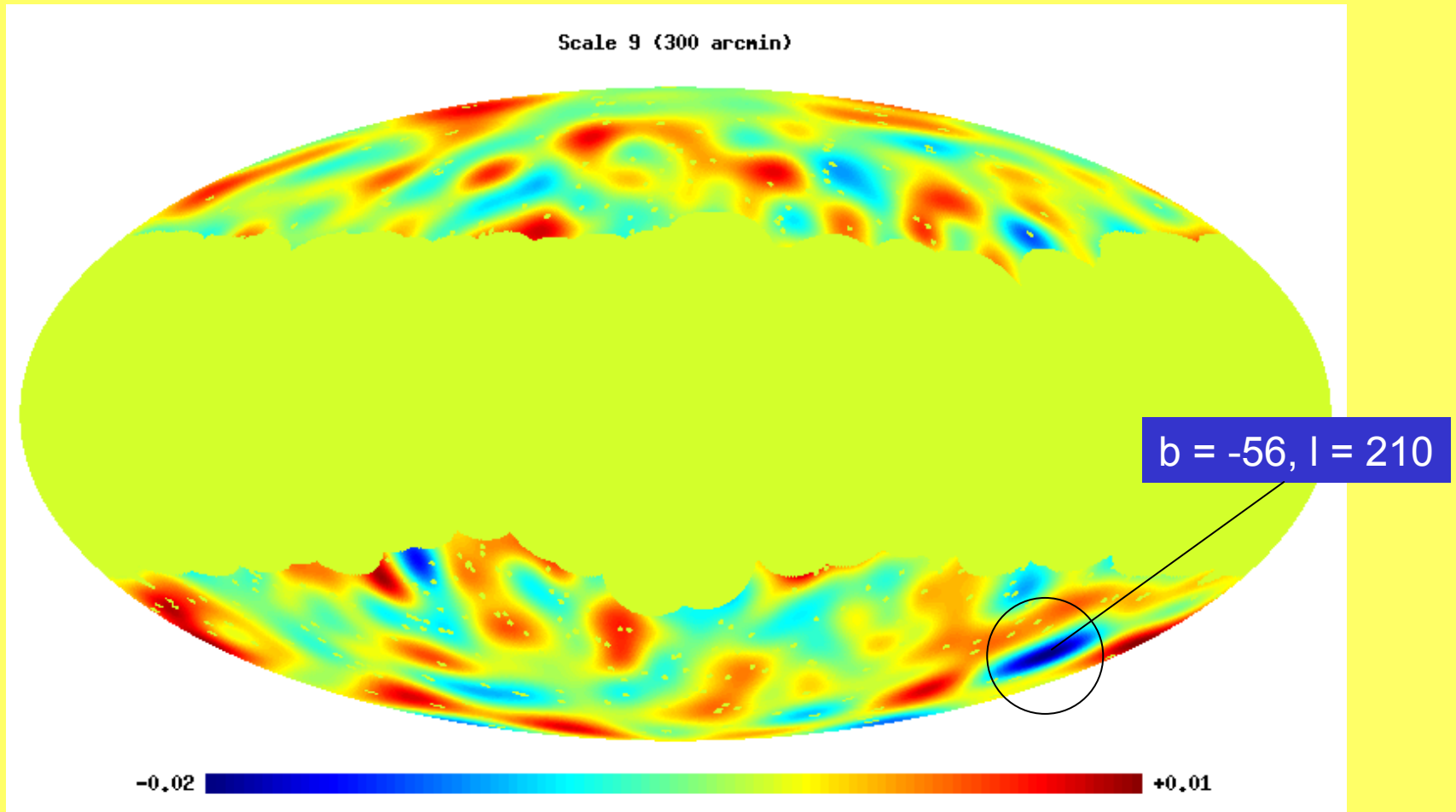IAP Colloquium Paris 2004

North and South
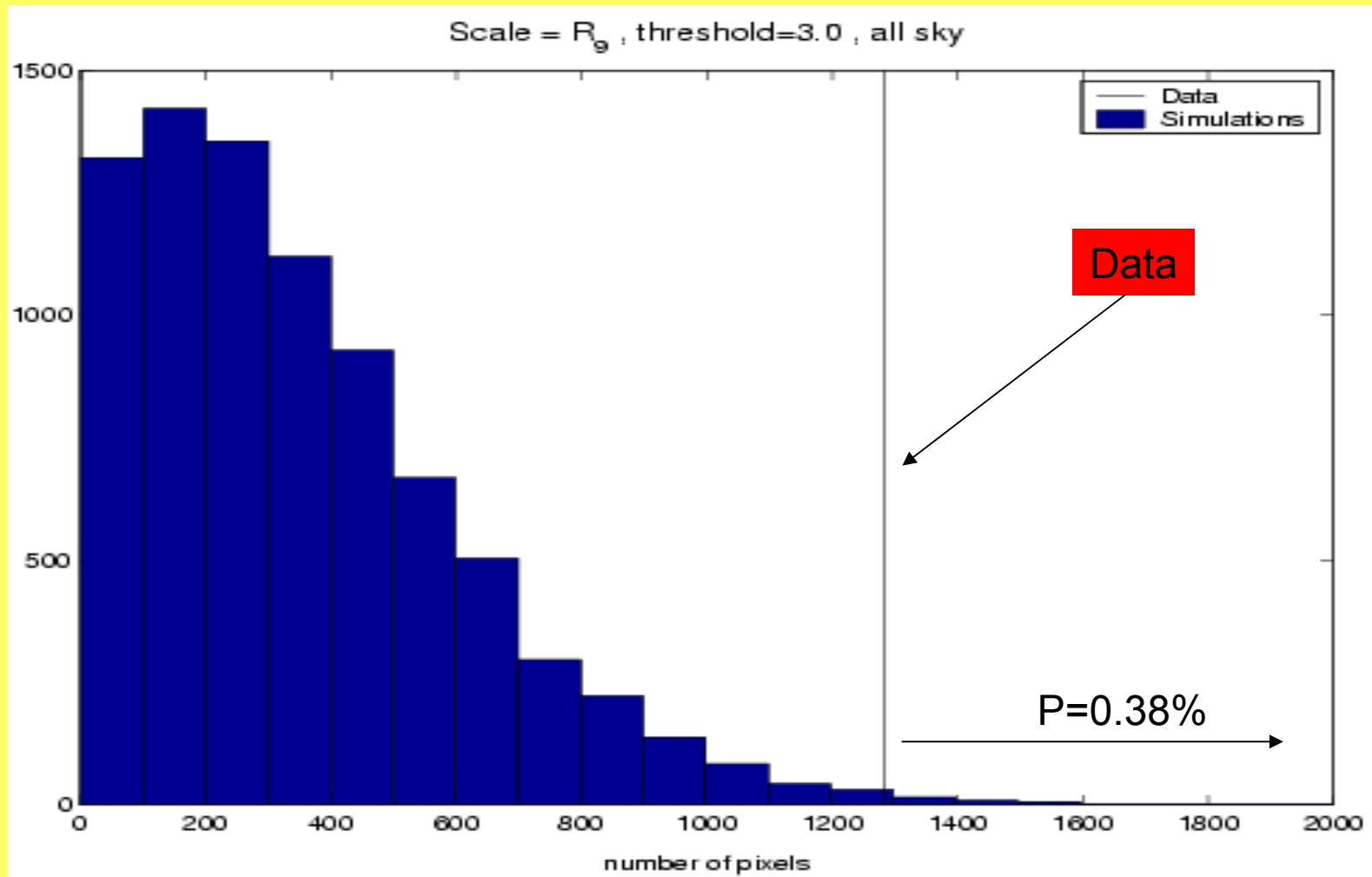
What is happening at scales 8, 9?

- North → Gaussianity
- **South** → Non-Gaussianity
- Hot → Gaussianity
- **Cold** → Non-Gaussianity
- Only **one spot** under - 4.0 ν
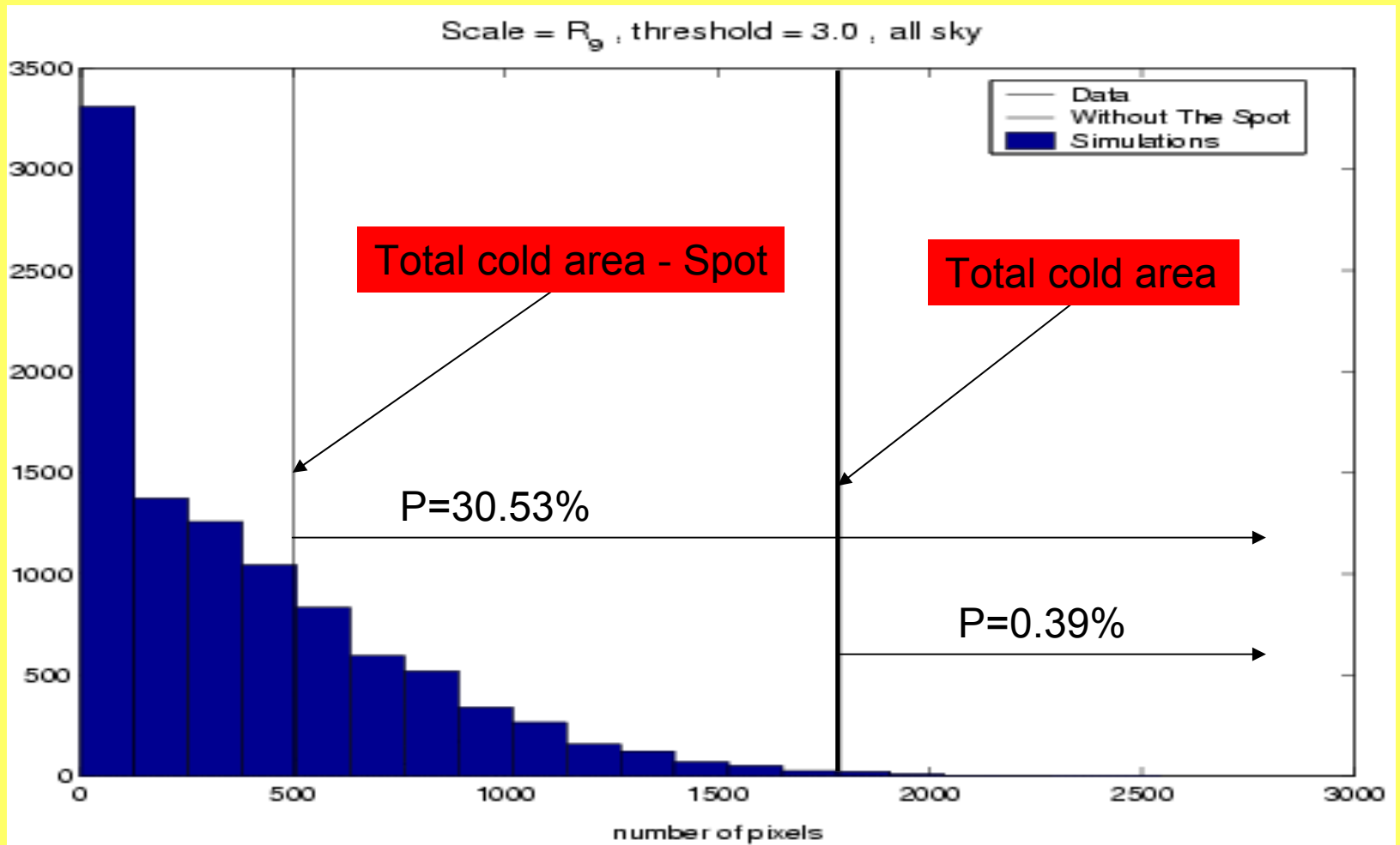
One non-Gaussian cold spot in the south

The Spot

Scale 9 (300 arcmin)

b = -56, l = 210

−0.02   +0.01

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The Spot vs. simulations

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Data = Gaussian field + Spot

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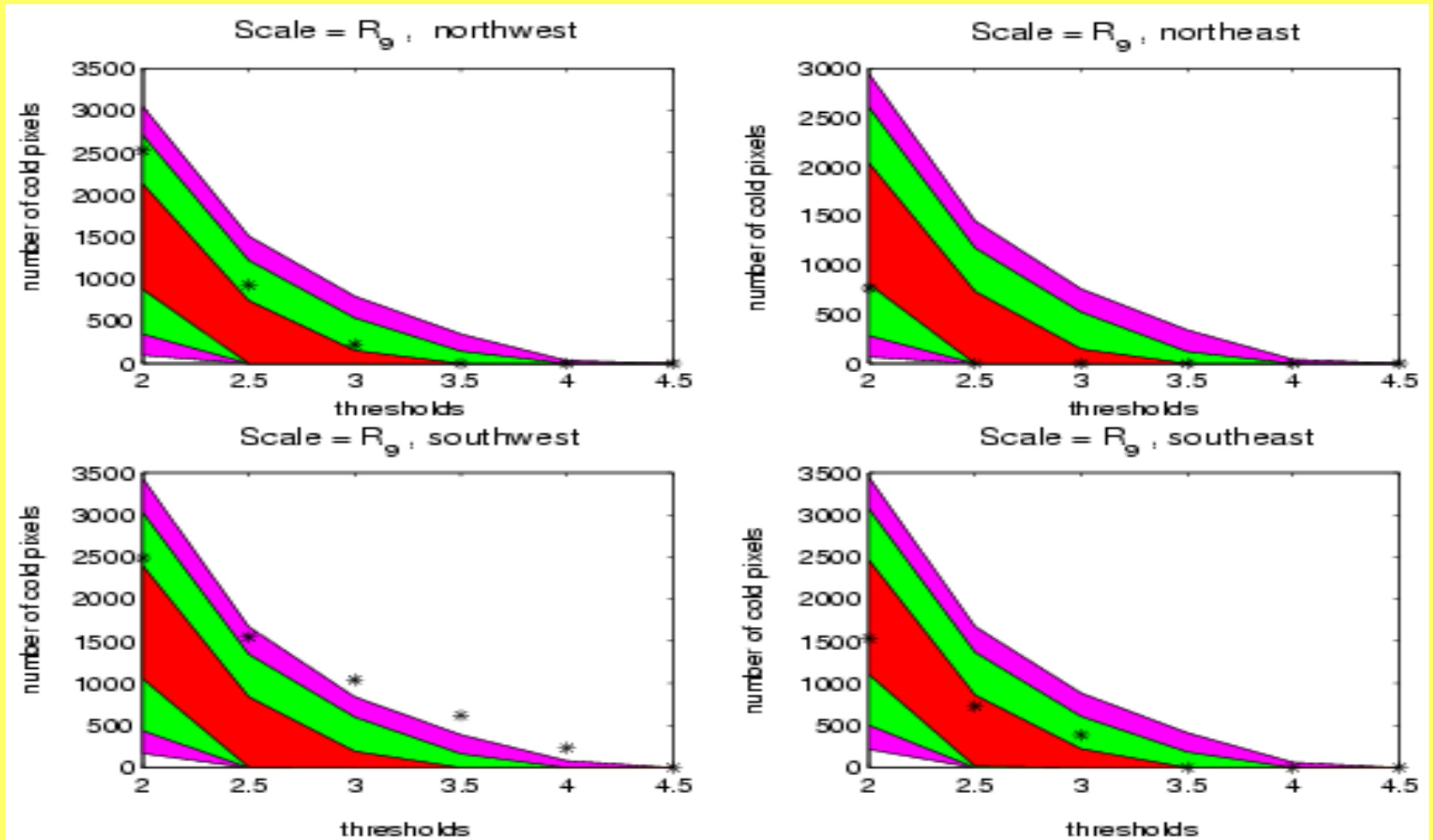# Sources of Non-Gaussianity

- Gaussian field : Standard inflation
- Spot:
  - Foregrounds?
  - Noise, beams? (systematics)
  - Sunyaev-Zeldovich?
  - Rees-Sciama?
  - Topological defects?
  - Non-standard inflation?
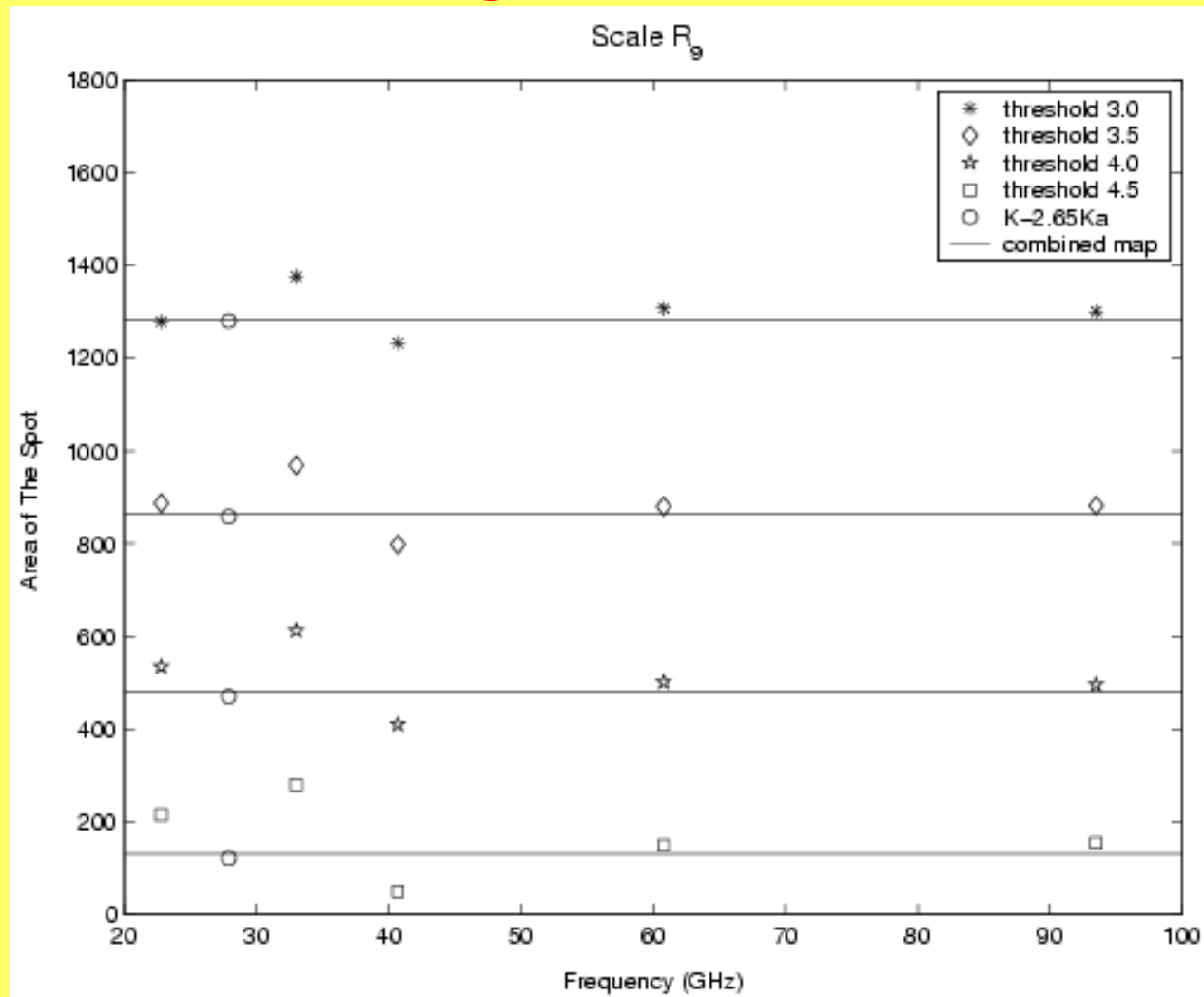
Conclusions

- 1-year WMAP data, 10000 simulations
- Spherical wavelets
- Cold spot b = -57º, l = 209º
- Covers 10º in the sky
- Real space: plateau + 4 resolved spots
- Gaussian model $\rightarrow$ P = 0.38% (ν = -3)
  $\rightarrow$ P = 0.18% (ν = -4)
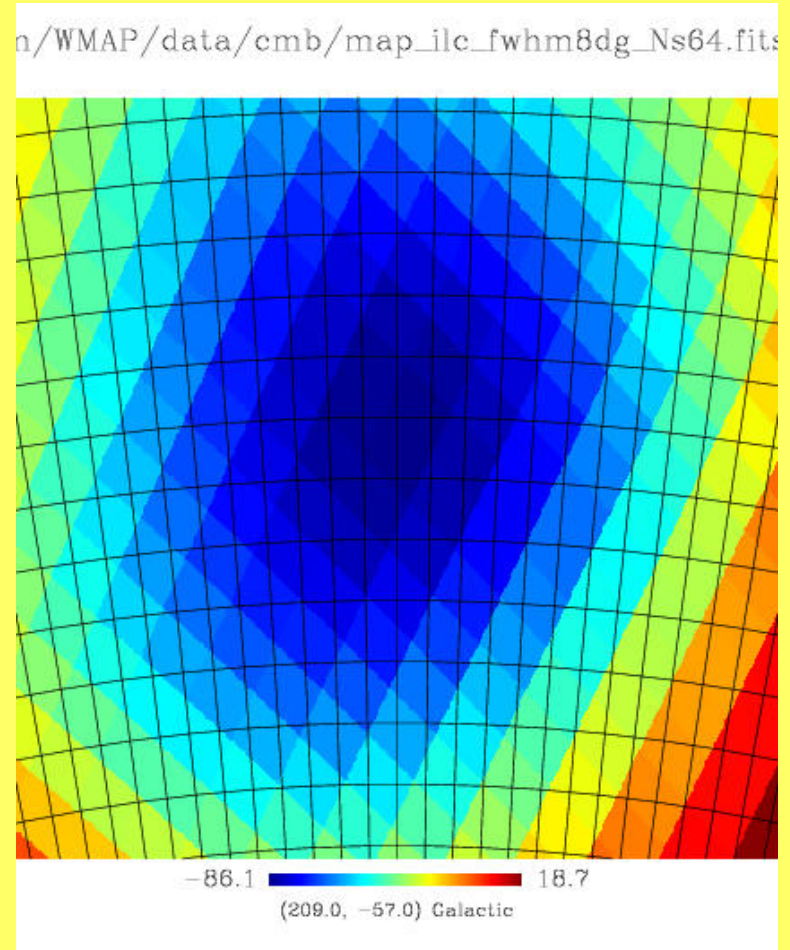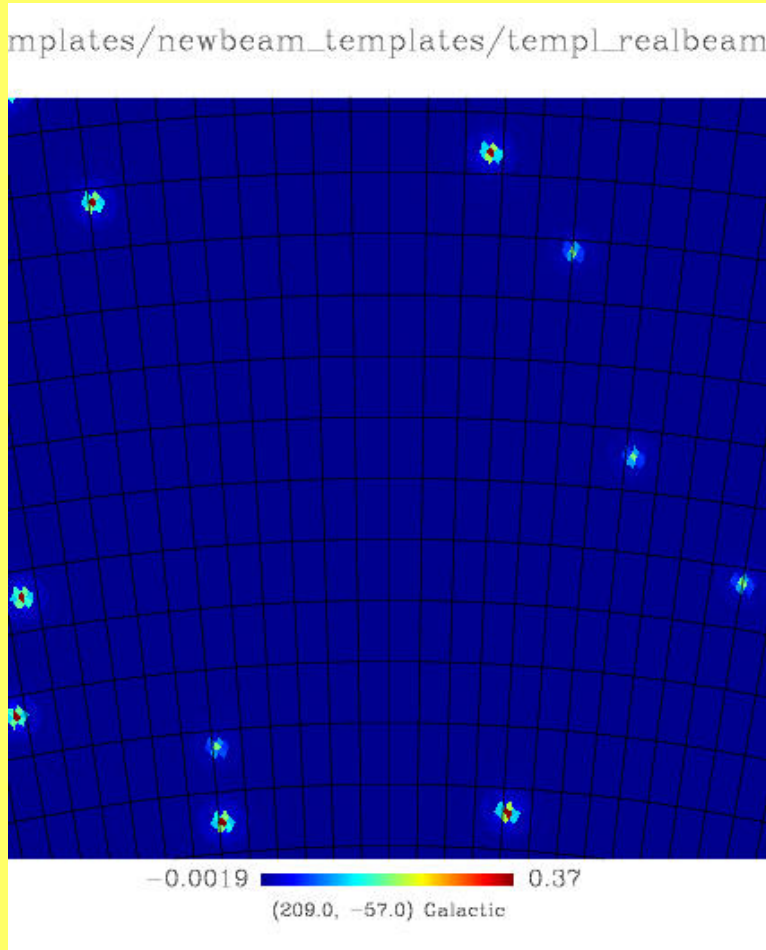- Not due to systematics, foregrounds, SZ

Four Regions

Foreground test

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SZ test

ACO catalogue

WMAP data

Many thanks to C. Hernández-Monteagudo

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